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(71) Applicant: HORIBA, LTD.
2 Miyanohigashi-machi Kissyoin
Minami-ku Kyoto(JP)

(72) Inventor: Ukon, Juichiro
6 Go, 16 Ban, 3-Chome, Nishifukui
Ibaraki-city, Osaka(JP)

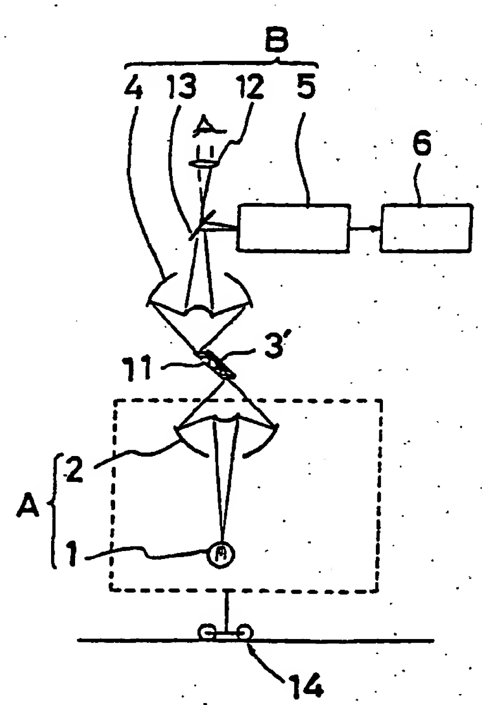
(74) Representative: TER MEER - MÜLLER - STEINMEISTER & PARTNER
Mauerkircherstrasse 45
W-8000 München 80(DE)

(54) Infrared microscopic spectrometer.

(57) An infrared microscopic spectrometer is composed of a collecting element portion (A), a focusing-into-an image portion (B) and of a transferring mechanism (14) for shifting one of said portions (A, B) toward each other in a direction meeting at right angels with an optical axis. The collecting element portion (A) contains a light source (1) and a condenser mirror (2) whereas the focusing-into-an image element portion (B) contains an object mirror (4) and a spectrometrical measurement system (5). An ATR crystal is to be positioned between the portions (A) and (B) so as to carry out the ATR analysis.

Fig. 1

(b)



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INFRARED MICROSCOPIC SPECTROMETER

Field of the Invention

The present invention relates to an infrared microscopic spectrometer as claimed in the preamble of claim 1.

Description of the Prior Art

Referring to Fig. 2 shoring a conventional general infrared microscopic spectrometer, infrared rays from a light source 1 are incident upon a sample 3 through a condenser mirror 2 and the transmitted light is enlargedly focused into an image by means of an object mirror 4. From this light a spectrum is obtained by means of a spectrometer system 5 and a display device 6 in order to conduct an analysis.

Further, for a substance having an extraordinarily strong absorption so that it is difficult to obtain a transmission spectrum and in case where it is difficult to prepare a sample so as to obtain the transmission spectrum and the like the well known ATR (Attenuated Total Reflection) method is applied in the field of infrared spectrometry.

Referring to Fig. 3 roughly showing a part of a general infrared spectrometer for conducting the ATR method, reference numerals 7,8 designate collecting mirrors and reference numerals 9, 10 designate further mirrors. An optical medium as a reflecting medium having a high refractive index, for example an ATR crystal 11 made of a refractive material, such as KRS-5, germanium and silicon, is disposed in an optical path formed between said mirrors 9, 10 and a sample 3′ is disposed on one surface of said ATR crystal 11 and in contact therewith.

In an infrared spectrometer for conducting the ATR method and having the above described construction, when infrared rays from a light source (not shown) are incident upon the ATR crystal 11 via the collecting mirror 7 and the mirror 9, said infrared rays are totally reflected by a contact surface with said sample 3′. However, infrared rays having specified wavelengths are absorbed by an ingredient to be measured in the sample 3′ according to a kind of functional group of said ingredient to be measured. On the other hand, infrared rays, which have passed through the ATR crystal 11 and being totally reflected, are incident upon a spectrometer (not shown) via the mirror 10 and the collecting mirror 8 in order to obtain a spectrum corresponding to the ingredient to be measured.

As to the infrared microscopic spectrometer discussed under Fig. 2 infrared rays from the light source 1 are collectedly incident upon the sample 3 by means of the condenser mirror 2 and the transmitted light is enlargedly focused into an image, so that it is natural that the condenser mirror 2 and an object mirror 4 must be coaxially arranged.

On the other hand, as obvious also from Fig. 3, in the ATR method an optical axis of infrared rays incident upon the ATR crystal 11 does not coincide with an optical axis of infrared rays emitted while being totally reflected, so that the ATR method has not been applied to the infrared microscopic spectrometer.

Accordingly, it is required to selectively use the apparatus depending upon the sample to be measured. This has led to a remarkably reduced efficiency.

It is an object of the present invention to provide an infrared microscopic spectrometer capable of carrying out also the ATR analysis by a simple operation.

The solution of this object is described in the characterzing portion of claim 1.

According to the present invention in an infrared microscopic spectrometer a transferring mechanism capable of shifting one of a collecting element portion and an enlargedly focusing-into-an-image element portion toward the other in a direction meeting at right angels with an optical axis is provided and an ATR crystal is disposed between said collecting element portion and said enlargedly focusing-into-an-image element portion so as to carry out the ATR analysis.

With the above described characteristic construction, since one of the collecting element portion and the enlargedly focusing-into-an-image element portion can be shifted toward the other in the direction meeting at right angels with the optical axis, the ATR analysis can be carried out by means of the infrared microscopic spectrometer and the apparatus can be efficiently used.

In addition, since also the optical regulation in the measurement by the ATR method can be carried out with observing by the function as an infrared microscope, a highly accurate regulation is possible.

One preferred embodiment of the infrared microscopic spectrometer according to the present invention is shown in Figs. 1(a), 1(b), in which

Fig. 1(a) is an optical arrangement plan for use in the transmission type infrared microscopic spectrometry; and

Fig. 1(b) is an optical arrangement plan for use in the ATR method infrared microscopic spectrometry.

The prior art is shown in Figs. 2,3, in which

Fig. 2 is an arrangement plan showing the conventional transmission type infrared spectrometer; and

Fig. 3 is an arrangement plan showing the conventional ATR method infrared spectrometer.

The preferred embodiment of the present invention will be described below with reference to the drawings.

Figs. 1(a), 1(b) show one example of a construction of an infrared microscopic spectrometer according to the present invention Referring to Figs. 1(a), 1(b), same reference numerals as in Fig. 2 and Fig. 3 designate same or corresponding members.

Referring to Fig. 1(a), A designates a collecting element portion consisting of a light source 1 and a condenser mirror 2 and B designates an enlargedly focusing-into-an-image element portion consisting of an object mirror 4, a spectrometrical measurement systems, an eyepiece 12 and an optical path-change over mirror 13.

Visible rays from the light source 1 are incident upon sample 3 through said condenser mirror 2 and the transmitted light is enlargedly focused into an image by means of said object mirror 4 followed by observing an image of said sample 3 by means of said eyepiece 12.

On the other hand, in the case where the spectrometric measurement is carried out, light is led to said spectrometrical measurement system 5 by changing-over the light source 1 to the infrared ray side and disposing said optical path-change over mirror 13 between the object mirror 4 and the eyepiece 12 to obtain a spectrum by means of the spectrometer within this spectrometrical measurement system 5. The spectrum is displayed by means of a display 6 connected to said system 5.

Here, the infrared microscopic spectrometer shown in Fig. 1(a) is remarkably different form the conventional infrared microscopic spectrometer in that a mechanism capable of shifting the collecting element portion A in the direction meeting at right angels with an optical axis, for example a slide mechanism 14 of manually or automatically shifting the collecting element portion a, is provided.

Accordingly, in the case where the measurement is carried out by the AIR method, a shift between the incident infrared rays and the transmitted infrared ray in optical axis brought about at an ATR crystal 11 is merely compensated by previously transferring the collecting element portion A by means of said slide mechanism 14 to carry out the measurement in the same manner as in the usual transmission type infrared microscopic spectrometer, as shown in Fig. 1(b).

That is to say, visible rays form a light source 1 collected by means of the condenser mirror 2 are incident upon an end face of said ATR crystal 11 provided so as to be brought into contact with a sample 3′ and a light emitted while being totally reflected within the ATR crystal 11 is enlargedly focused into an image by means of the object mirror 4. So, said end face of the ATR crystal is observed by means of the eyepiece 12 to carry out the regulation of light passing through the ATR crystal 11 in optical axis.

Subsequently, in the ATR analysis the light source 1 is changed over to the infrared side to lead the light to the spectrometrical measurement system 5 by means of the optical path-changing over mirror 13, whereby carrying out the analysis.

In addition, the slide mechanism 14 is marked at a position of the collecting element portion A for the usual infrared microscopy and a position of the collecting element portion A for the ATR method or a limit switch is provided in the case, where said slide mechanism 14 is transferred by means of a motor and the like, to improve the reproductivity.

Although the collecting element portion A is provided with the slide mechanism 14 to be transferred in the present preferred embodiment, the enlargedly focusing-into-an-image element portion B may be provided with the slide mechanism 14 to be transferred.

In addition, although a transmission type infrared microscopic spectrometer is described in the present embodiment, it goes without saying that the present invention can be applied also to a reflection type infrared microscopic spectrometer.

As above described, according to the present invention, the infrared spectrometry by the ATR method can be carried out by means of the infrared microscopic spectrometer by merely transferring either the collecting element portion A or the enlargedly focusing-into-an-image element portion B in the direction meeting at right angels with the optical axis and the apparatus can be efficiently used. In ad dition, also the optical regulation in the measurement by the ATR method can be very accurately carried out by the function of the infrared microscope.

Claims

1. An infrared microscopic spectrometer comprising:

- a light source (1),
- a condenser mirror (2) for collecting the light emitted from the light source (1) and for irradiating a sample (3,3′) with said collected light,
- an object mirror (4) for focusing the light transmitted through or reflected form said sample (3,3′), and
- a spectrometrical measurement system(5) for receiving and analysing the light focused by said

object mirror (4),
characterized in that
- a collecting element portion (A) containing the light source (1) and the condenser mirror (2) and a focusing-into-an-image element portion (B) containing the object mirror (4) and the spectrometrical measurement system (5) are constructed as separate portions,
- a transferring mechanism is provided capable of shifting one of the collecting element portion (A) and the focusing-into-an-image element portion (B) toward each other in a direction meeting at right angles with an optical axis, and
- an ATR crystal (3′) is to be disposed between the collecting element portion (A) and the focusing-into-an- image element portion (B) so as to carry out the ATR analysis.

2. An infrared microscopic spectrometer as claimed in claim 1, **characterized in that** the light source (1) is able to emit visible light and infrared light, respectively, and an optical path-change over mirror (13) is provided within the focusing-into-an-image element portion (B) for guiding the visible light to an eyepiece (12) and the infrared light to the spectrometrical measurement system (5).

3. An infrared microscopic spectrometer as claimed in claims 1 or 2, **characterized in that** the transferring mechanism (14) is constructed to shift the collecting element portion (A).

4. An infrared microscopic spectrometer as claimed in claims 1, 2 or 3, **characterized in that** marks or limit switches are provided in order to ensure the correct relative position between the portions A and B.

Fig. 1

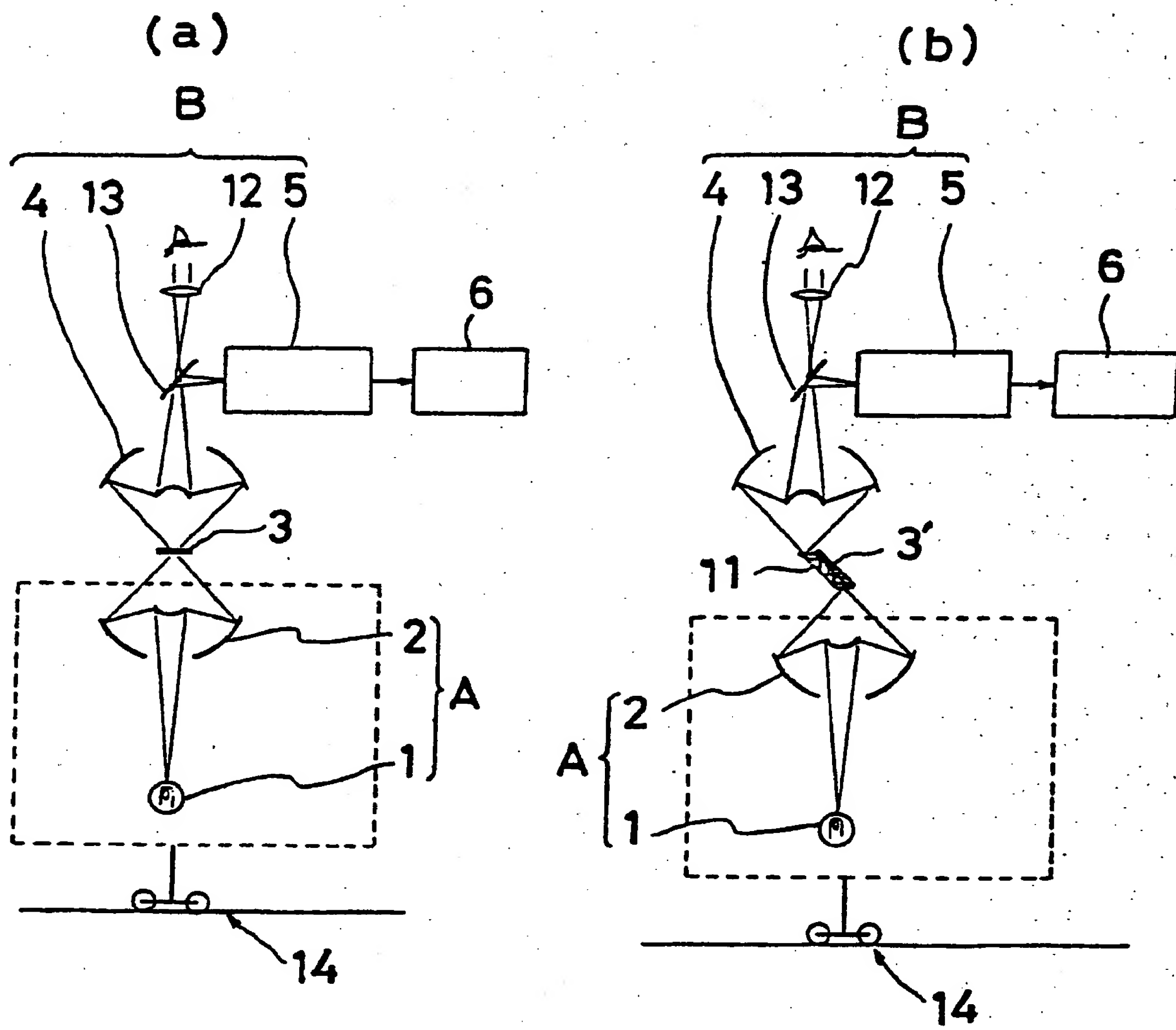


Fig. 2

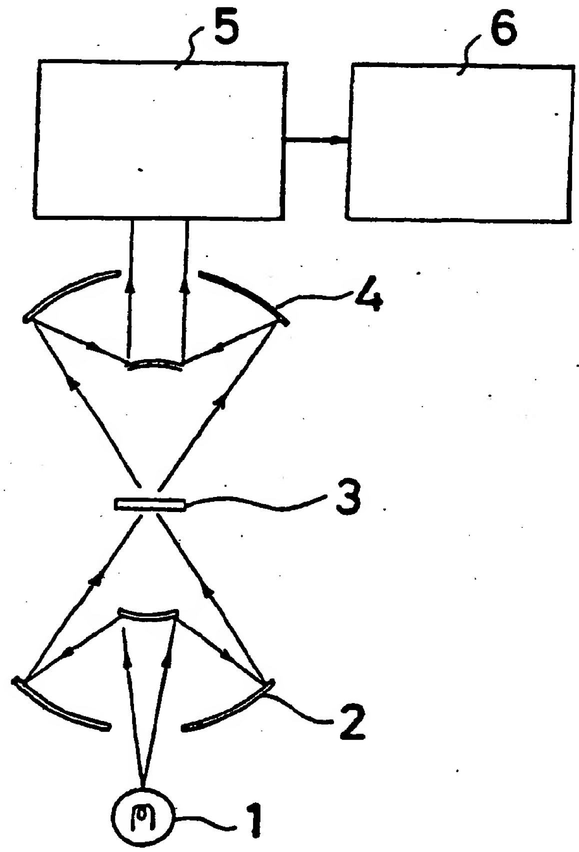
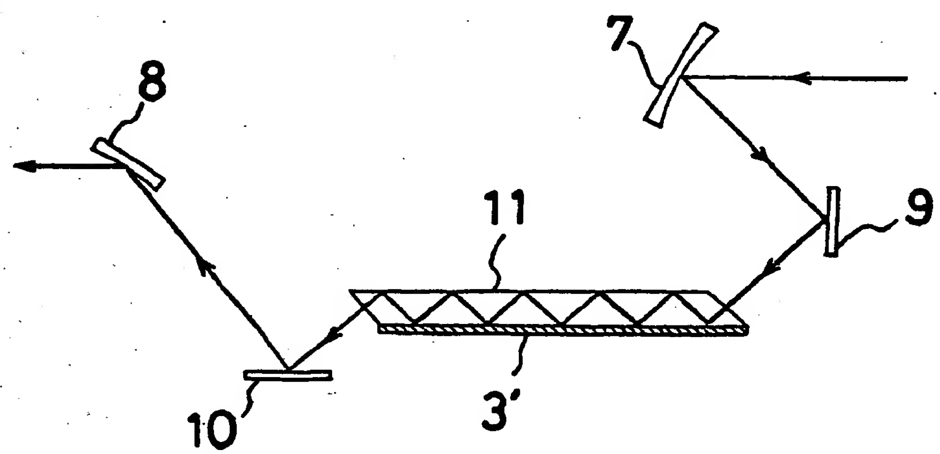


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number

EP 90 11 9771

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 591 266 (W.M. DOYLE) * column 1, line 45 - column 2, line 19; column 6, lines 21-63; column 7, lines 55-62; figures 1,2,5 * ---	1,3	G 01 N 21/55 G 02 B 21/00 G 02 B 21/04
X	GB-A-2 136 594 (NICOLET INSTRUMENT CORP.) * abstract; figures 1,2; claim 9 * ---	1	
A	EP-A-0 116 321 (BRUKER ANALYTISCHE MESSTECHNIK) * page 16, last paragraph - page 17, last paragraph; figures 1,4 * ---	1,2	
A	DE-B-2 462 110 (WILHELM WILL KG) * figure 3 * -----	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5) G 02 B G 01 N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	08-02-1991	VON MOERS F

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